DOCUMENT MODIFICATION REQUEST (DMR)

Refer to 1-A01-PPG-001 for Processing Instructions
Print or Type All Information (Except Signatures)

1 Date 9/27/94	25 DMR No 9~~3~~4-DMR-001997 10/19/94
2 Existing Document Number/Revision 5 21000-OPS-GT 18 Rev 2	3 New Document Number or Document Number if it is to be changed with this Revision N/A
4 Originator's Name/Phone/Page/Location Steve Paris/8543/4624/Bldg 080	5 Document Title Surface Geophysical Surveys
6 Document Type ☒ Procedure ☐ Other ______	7 Document Modification Type (Check only one) SL 10 14 94 ☐ New ☐ Revision ☒ Intent Change ~~☒~~ Nonintent Change ☐ Editorial Correction ☐ Cancellation

8 Item	9 Page	10 Step	11 Proposed Modifications
1	24		Insert Section 5 4 Seismic Refraction
2	N/A		Insert Form GT 18B Seismic Refraction Survey Observer's Report
3	N/A		Insert Form GT 18D Ground Penetration Radar Survey Observer's Report
			Limited Scope to OU4

12 Justification (Reason for Modification, EJO# TP# etc)

SOP for performance of Seismic Refraction Surveys at OU4 for Phase II activities Forms needed to ensure SOP's are being followed.

SCOPE LIMITATION OU-4 SL 10 14 94

If modification is for a new procedure or a revision, list concurring disciplines in Block 13 and enter N/A in Blocks 14 and 15 If modification is for any type of change or a cancellation, organizations are listed in Block 13 then Concurror prints and signs in Block 14 and dates in Block 15

13 Organization	14 Print and Sign (if applicable)	15 Date (if applicable)
QAPM	S LUKER [signature]	10 14 94
~~EQS~~	n/a [initials]	
~~EOM~~	n/a [initials]	
OU4	S.M. PARIS [signature]	10-18-94
SME	FRED Grigsby [signature]	10-18-94

16 Originator's Supervisor (print/sign/date) Randy T Ogg [signature]				
17 Assigned SME/Phone/Page/Location Fred Grigsby/6929/7469/Bld 080	18 Cost Center	19 Charge Number	20 Requested Completion Date Oct. 10 1994	21 Effective Date 10/27/94
22 Accelerated Review? Yes ☒ No ☐	23 ORC Review NOT REQUIRED			
24 Responsible Manager (print, sign, date) ~~Randy T Ogg~~ J.A. LEDFORD [signature] 10/10/94				

REVIEWED FOR CLASSIFICATION/UCNI
BY NA
DATE NA

DOCUMENT CLASSIFICATION REVIEW WAIVER
PER R B HOFFMAN, CLASSIFICATION OFFICE
JUNE 11, 1991

ADMIN RECORD

93F00021 001

MEMORANDUM

DATE· October 19, 1994

TO: History File

From: Steve Paris, Group 1 Closures, Bldg. 080, X8543

RE: Document Modification Request (DMR) to SOP GT.18 Surface Geophysical Surveys

Document Modification Request 94-DMR-001997 to SOP GT 18 Surface Geophysical Surveys limited to Operable Unit No 4, Solar Evaporation Ponds can be distributed to the following individuals

Kenneth Pacheco	- Tierra Environmental Consultant, Inc ,
Steven Paris	- EG&G Rocky Flats, Inc ,
Fred Grigsby	- EG&G Rocky Flats, Inc , and
Peter Bierbaum	- ERM - Rocky Mountain, Inc

cc R T Ogg

LIST TO TABLES

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LIST OF EFFECTIVE PAGES

Pages	Effective Date	Change Number
24-25	10/27/94	94-DMR-001997
Form GT 18B	10/27/94	94-DMR-001997
Form GT 18D	10/27/94	94-DMR-001997

TOTAL NUMBER OF PAGES 9 (including forms) for the base, this "tie-in" correction must be included in the final SP value for each measured station.

Most interpretations of SP data are performed qualitatively, involving preparation of data profiles and contour maps, and assessing the resulting anomalies Experienced interpretation considers all potential sources of a given SP anomaly and assesses whether the anomaly is characteristic of the suspected target anomaly

More sophistcated interpretation techniques can be employed, particularly when corroborative information exists, such as boring data or data from other geophysical methods These other techniques include geometric and analytical modeling The use of these techniques must be evaluated on a project-specific basis, with discussion and approval of their merit by EG&G personnel

5 4 SEISMIC REFRACTION

5 4 1 Introduction

The seismic refraction method utilizes a seismic source to generate seismic waves that propagate through the subsurface and are detected by an array of receivers known as seismometers or geophones, located on the surface Seismic refraction is used to map seismic refractors A refractor is a geologic unit that has a higher seismic velocity than the overlying geologic unit A seismic wave will refract from the top of a refractor at a critical angle defined by Snell's Law (see Dobrin (1976) or Telford (1976)) The critical angle of refraction, i_c, is related to the velocity of the overlying and underlying geologic media by the following equation

$$\sin i_c = \frac{V_0}{V_1}$$

where V_0 is the seismic velocity of the overlying geologic unit and V_1 is the seismic velocity of the underlying unit (i e refractor) The refracted seismic wave travels back to the surface to be detected by geophones Because the refracted wave travels along the interface between unit 0 and unit 1 at velocity V_1, it follows that at

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some distance from the source, the refractor will arrive before the direct wave, which travels at velocity V_0

The success of the seismic refraction technique is dependent on a number of factors, such as the depth to the refractor, the number and nature of intervening refractors and geologic units, the velocity contrast between the overlying and underlying units, the nature of the seismic source, the distance from the source to the receiver, the amplitude of the refractor, and the amount of ambient noise

Seismic sources generate a number of seismic events including surface waves, direct waves, compressional waves, shear waves, and subsequent transmitted waves, reflected waves, refracted waves, and converted waves These different waves are detected by the geophones converting mechanical vibrations into electrical voltages The electrical voltages are transmitted to the seismograph, digitized, and recorded in electronic form The seismograph normally has a number of recording channels, one for each geophone on the ground The seismograph starts recording at the instant that the seismic source is activated The seismograph will digitize the voltage reading at each channel at predetermined time intervals, known as the sampling rate, until the maximum recording time is reached The display of the recorded data from one channel is called a trace The collection of all traces from one seismic recording is called a record The seismic events of most interest for seismic refraction are the direct wave and the refracted waves, known as first breaks These events are recorded in elapsed time originating at the activation of the seismic source

Most seismic sources generate compressional waves also known as P-waves Surveys can be designed to generate and record shear waves also known as S-waves S-waves do not propagate through liquids or gases and therefore they are not affected by the presence of the water table This can be useful in areas where a water table P-wave refraction event may interfere with mapping another geologic unit

Many shallow investigations use hammers or other types of impact devices to generate seismic energy In most cases one impact of the hammer is not sufficient energy A technique called vertical stacking can be used to enhance the energy from a single hammer blow Multiple blows are recorded and the individual records are added together within the seismograph This results in the cancellation of random noise, and the desired seismic signal is enhanced

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Seismic refraction data can be used to map one or more refractors There are a number of techniques available to interpret the seismic record in terms of geologic units The most widely used technique is the generalized reciprocal method (GRM) The GRM method uses forward and reverse shots to add statistical confidence in the interpretation of the seismic refraction data

This section of the SOP specifies procedures for surveys utilizing the seismic refraction method This SOP has been written to allow the geophysicist the necessary flexibility to design the refraction survey to accomplish specific project objectives Because geophysical technology is constantly upgrading, no specific procedures have been written for any particular piece of equipment The selection of specific equipment depends on project objectives, budget, and best-available-technology (BAT)

5 4 2 Survey Design

5 4 2 1 <u>List of Necessary Equipment</u>

- Digital Seismograph
- Geophones and cables
- Flagging
- Wooden Stakes
- Field Notebook
- Black waterproof (permanent) pen
- Tape measure (200 feet minimum) or equivalent

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- Seismic source

- Seismic trigger mechanism or switch

5 4 2 2 Field Procedures

A standard field procedure for collecting seismic refraction data is described below Prior to data collection, two preliminary procedures must be conducted These are

- Design the appropriate field parameters, given the purpose of the survey (e g , orientation of lines or grid, geophone spacing, frequency of geophones, seismic source selection, number of source locations, and number of channels) and the technique to be used to reduce the data (e g , GRM method)

- Survey line endpoints and mark these locations in the field with stakes Mark geophone and source locations with flags or stakes Gather elevation data of station locations where slope breaks may effect data processing and interpretation Transfer line locations to the correct position on the base maps

Design of appropriate field parameters must consider the following

- The seismic source must generate sufficient energy to overcome ambient noise and generate a refraction event that has a significant signal to noise ratio to allow the accurate picking of the arrival time

- The geometry of the source and receiver station locations must provide the necessary resolution to meet the objectives of the survey Blind and hidden layers will normally not be detectable

A standard field procedure for conducting a seismic refraction survey is described below

Perform a visual survey along the proposed lines The visual survey will include a review of site utility plans, check for manhole covers, buried cables, buried gas line indicators, and cased monitor wells, and have site locators confirm the presence of any possible telephone and utility features Note features in the field notebook Move source locations as necessary depending on source type

Note in the field notebook large variations in topography in the survey area including soil changes and water features

Set up a test line Test survey parameters in a representative area or near known geologic information Modify the survey parameters as necessary Check equipment for proper operation according to manufacturer's specifications

Conduct seismic refraction survey If localized conditions change sufficiently, then survey parameters may be modified to meet project objectives

If hard copies of a seismic record are made sufficient notations must be made on the record to identify the record

All data must be retained in digital format on tape disk or other electronic media Hard copy plots of all final records must be made and retained

Information about the survey geometry and each source location may be written on a seismic observer's report or form, or recorded in digital format on the record header

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5 4 3 Data Reduction and Interpretation

Data reduction of seismic refraction data has many techniques depending on the data quality and the complexity of the local geology The arrival time of the first breaks are picked on each trace and time-distance plots are made In most cases the generalized reciprocal method (GRM) provides the best technique for reducing the refraction data The geophysicist should choose a technique that allows the maximum extraction of information from the data set

Interpretation must consider geological concepts and known geological data Information from other geophysical techniques can enhance the interpretation process by narrowing the number of possible geologic models Forward and inverse computer modelling can provide a quick method to test the potential geologic models The final interpretation should present geophysical properties as well as geological equivalents

5 4 4 References

Dobrin, M B , 1976, Introduction to Geophysical Prospecting, 3rd ed New York, McGraw-Hill Book Co , Inc

Telford, W M , Geldard L P , Sheriff, R E , and Keys, D A , 1976, Applied Geophysics, New York, Cambridge University Press

6 0 DECONTAMINATION

Personnel involved with surface geophysical surveys will follow all decontamination procedures as outlined in the Health and Safety Plan Geophysical equipment which has been in contact with potentially contaminated ground surfaces will be decontaminated according to procedures outlined in SOP FO 3, General Equipment Decontamination, as well as any appropriated procedures specified in the Health and Safety Plan

7 0 DOCUMENTATION

A permanent record of the implementation of this SOP will be kept by documenting field observations and data The date of the manufacturer's most recent calibration and certification will be documented, if this information is available Observations and data will be recorded with black waterproof (permanent) ink in a bound, weatherproof field notebook and consecutively numbered pages Documentation of completed decontamination activities will be similarly noted When conducting SP surveys, data and observations will be documented on the Self-Potential Survey Data Form (Form GT 18A)

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DEPARTMENT OF ENERGY ROCKY FLATS PLANT | FORM GT 18B (REV 2)

SEISMIC REFRACTION SURVEY OBSERVER'S REPORT

Project	Location
County	State

Instruments

Manufacturer		Model	Serial No
Gain	db	No of Channels	
Receivers	Manufacturer		
Model	Frequency Hz		
Filters			
Locut	Hz	slope	db/octave
Hicut	Hz	slope	db/octave
Other			

Record Length	milliseconds
Sample Rate	milliseconds
Recording Media	Format
	Density

Draw Line Geometry on back if necessary

Line ID	Spread No			Geophone Spacing			
				Source			
SP#	SP Loc	SP offset	Type	No	Media#	Record#	Remarks

Line ID	Spread No			Geophone Spacing			
				Source			
SP#	SP Loc	SP offset	Type	No	Media#	Record#	Remarks

Line ID	Spread No			Geophone Spacing			
				Source			
SP#	SP Loc	SP offset	Type	No	Media#	Record#	Remarks

Observer ______________________ Date ______________________

DEPARTMENT OF ENERGY ROCKY FLATS PLANT

FORM GT 18D (REV.2)

GROUND PENETRATING RADAR SURVEY OBSERVER'S REPORT

Page 1 of 1

Project	Location	
County	State	
Instruments		
Manufacturer	Model	Serial No
Signal Range Gain	No of Channels	
Antenna Frequency MHz		
Filters		
Hi Pass	Lo Pass	
Other		
Transmitter Pulse Rate	Scan Speed	
Antenna Towing Speed	Recorder Printer Speed	
Recording Media	Format	
	Density	

Draw Line Geometry on back if necessary

Line ID	Start Station	End Station	Time Range	Antenna Separation	Media No	File ID	Remarks

Observer ______________________ Date ______________________